IV THE NEUROLOGIC SYSTEM

WEIR MITCHELL OF PHILADELPHIA

American neurology really began during the Civil War, chiefly through the work of S. Weir Mitchell and William A. Hammond. Appointed as surgeon-general of the U.S. Army Medical Department in 1862, Hammond undertook many projects and reforms, including the establishment of Turner's Lane Hospital outside of Philadelphia. In that 400-bed hospital devoted exclusively to the care of soldiers with neurologic disorders, Mitchell distinguished himself as a clinician with powers of meticulous observation.

Born in Philadelphia in 1821, Mitchell attended the University of Pennsylvania and graduated from Jefferson Medical College in 1850 at age 21. He recalled later, "I made up my mind that by thirty-five I should have a chair in one or the other of the two great schools," a wish that was frustrated all his life. Mitchell was a general practitioner, conducting some research in toxicology, when the Civil War began. His interest in neurologic disorders became evident to his friend Hammond, who appointed him to a small army hospital in Philadelphia devoted to neurologic patients. After the battle of Gettysburg, the hospital was moved to a larger building on Turner's Lane to accommodate the wounded.

With the collaboration of George R. Morehouse and William W. Keen, Mitchell published in 1864 the classic book *Gunshot Wounds and Other Injuries of the Nerves.* They reported their first 18 months' experience, including a description of the clinical syndrome Mitchell later termed *causalgia,* a painful condition following injury to a large peripheral nerve. An expanded book written solely by Mitchell, *Injuries of the Nerves and Their Consequences,* was published in 1872. His son, John Kearsley Mitchell, described *Remote Consequences of Injuries to Nerves* in 1895, reporting a follow-up of 20 of the original patients. Mitchell and his colleagues

recognized the opportunity afforded by Turner's Lane Hospital, writing, "Never before in medical history has there been collected for study and treatment so remarkable a series of nerve injuries" (Mitchell, 1905). Their method of study began with an accurate account of each patient's symptoms and signs:

> *Keen, Morehouse, and I worked on at notetaking often as late as 12 or 1 at night, and when we got through walked home, talking over our cases. . . . The cases were of amazing interest. Here at one time were eighty epileptics, and every kind of nerve wound, palsies, choreas, stump disorders. (Mitchell, 1905)*

Causalgia was observed in numerous soldiers at Turner's Lane Hospital. The pain was described as an intense, diffuse, burning sensation, subject to exacerbation by stimuli, mental as well as physical. Treatment at the time included water dressings and morphine injections. Mitchell (1872) described causalgia as "the most terrible of all the tortures which a nerve wound may inflict." He was a master of clinical case descriptions, and the following is an account of a case of causalgia in a Union soldier wounded in battle:

> *H., aged thirty-nine, New York, was shot July 2, 1863, through the inner edge of the right biceps, half an inch above the internal condyle of the humerus; the ball passed backward and downward. The musket fell from his left hand, and the right, grasping the rod, was twisted towards the chest and bent at the elbow. He walked to the rear. He cannot tell how much motion was lost, but he knows that he had instant pain in the median distribution, with tenderness of the palm, even on the first day, and a sense of numbness. My notes described him on entering our wards as presenting the following symptoms: the temperature of the two palms is alike. The back of the hand looks as usual, but the skin of the palm is delicate and thin, and without eruption. The joints of the fingers are swollen, and the hand secretes freely a sour, ill-smelling sweat. The pain is, in the first place, neuralgic, and darting down the median nerve track into the fingers; while in the second place, there is burning in the palm and up the anterior face of the fingers.*
>
> *Pressure on the cicatrix gave no pain, but the median nerve below that point was tender, and pressure upon it caused pain in the hand. There was slight want of tactile sensibility in the median distribution in the hand, but the parts receiving the ulnar nerve presented no sign of injury. The hyperesthesia of the palm was excessive, so that even to blow on it seemed to give pain. He kept it wrapped up and wet, but could not endure to pour water on to the palm, preferring to wet the dorsum of the hand and allow the fluid to run around, so as by degrees to soak the palm. After a few weeks of this torment he became so sensitive that the rustle of a paper or of a woman's dress, the sound of feet, the noise of a band, all appeared to increase his pain. His countenance at this time was worn, pinched, anaemic, his temper irritable, and his manner so odd that some of the attendants believed him insane. When questioned as to his condition he assured me that every strong moral emotion made him worse,—anger or disappointment expressing themselves cruelly in the aching limb. (Mitchell, 1872)*

After the Civil War, Mitchell limited his practice to consultations in neurologic disease, for his reputation was wide and his service in demand. He made much of his living in psychiatry, however, with a particular interest in the treatment of hysteria in women. Friend of Oliver Wendell Holmes, William Osler, William James, and Walt Whitman, Mitchell made his mark in literature as well as medicine, as author of novels, short stories, and poems. In urging him to visit Boston, Holmes wrote to Mitchell, "I am lonely. You are the only friend of distinction left to me."

—CHARLES STEWART ROBERTS

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50 An Overview of the Nervous System

H. KENNETH WALKER

The collection of neurologic data begins when the patient is heard outside the office door. Listen to the cadence and sounds of the gait: the stamp of sensory ataxia; the short, festinating shuffle of the patient with parkinsonism; the alternating scuffling of a hemiparetic leg. Observation continues when the patient enters the door. Posture, gait, and stature are noted as the patient walks to the chair. Coordination of the extremities and fine movements of the hands are watched as the patient approaches the examiner, shakes hands, and sits. Observe the patient's hygiene carefully: appropriateness of dress, cleanliness of clothes and body, fastidiousness or lack of it. Odors can give important clinical information; uremia and ketosis are two obvious examples. Speech, language, and various aspects of the mental status can be assessed as conversation begins and continues. Emotional appropriateness and spontaneous speech are perhaps assessed better at this time than on formal testing later. Abnormal postures such as head tilt and titubation are visible. Involuntary movements such as twitches, facial synkinesia, and chorea may be obvious during this initial phase. This is the time consciously to form a general impression of the patient: status; general appearance; wasting; kyphosis; scoliosis; and systemic signs of disease (e.g., hyperthyroidism, myxedema, cachexia).

A considerable amount of information about cranial nerve function can be gained by inspection during the taking of the history: Field deficits may be obvious in the way the patient keeps the fovea centered on a moving examiner; fullness of eye movements; facial movements; unsynchronized blink or facial synkinesias of patients with previous Bell's palsy; the characteristic head movements of a patient who is deaf in one ear; dysarthria; swallowing problems; sternocleidomastoid weakness, atrophy, or spasm. Mild weakness of one extremity or hemiparesis is often best discerned by watching the unconscious movements of the patient as he or she picks at the clothes, fusses with hair, etc.

The examples given above just begin to scratch the surface of the information potentially available to the discerning observer. The information is given unwittingly by the patient, bereft of conscious motivation. A subtlety and richness of assessment is possible that cannot be achieved in the formal testing situation.

History

The neurologic history is one of the most challenging and satisfying components of the general history. The data collected lead the clinician to anatomic localization and etiologic considerations. The general principles of history taking given in Chapter 2 are relevant. The clinician begins with open-ended questions and ends with specific ones. Tailor the history to the urgency of the situation, the circumstances, and competence of the patient. A cross history is essential for many patients—from the spouse, other family members, associates, and bystanders. The telephone is often the most important instrument available. A meticulous examination of previous records is also necessary. Critical information, often unsuspected by the present or former clinician, is often found in them. Examine every detail in the past record, taking as your starting point the belief that you are looking at every fact in a fresh light; *never* accept previous conclusions at face value. Previous data frequently take on new significance in the light of what has occurred since then. The drug history is essential in any patient with neurologic problems. In fact, the plastic bag containing the patient's medications might even be considered one of the "instruments" used in the neurologic examination (Table 50.1).

A number of frequent symptoms explored in detail in this section are summarized below.

Episodic neurologic symptoms (Chapter 51) include some of the most frequent chief complaints in clinical medicine: transient loss of consciousness, dizziness, visual problems, weakness, paresthesias, etc. The underlying etiologies include seizures, cardiac arrhythmias, migraine attacks, transient ischemic attacks due to a variety of causes, vestibular disease, drug reactions, metabolic problems such as hypoglycemia, and many others. These complaints are challenging, often difficult, and give satisfaction to the patient and a sense of accomplishment to the physician when the correct diagnosis is reached. A good starting point in taking the history is to ask the patient, "How do you know you are about to have one of these attacks?" Then have the patient recount each symptom in temporal sequence, in an open-ended fashion. Next, take each symptom in the order of occurrence and ask the patient to describe each one in detail; often symptoms not mentioned previously will be remembered.

Pain and sensory perversions (Chapter 52) are common chief complaints. Pain localizes disease processes in the body with more accuracy than virtually any other symptom. Pain often has as fellow travelers associated symptoms that provide valuable clues to localization and etiology. The quintessen-

Table 50.1
Instruments Used in the Neurologic Examination

Scent such as vanilla
Snellen chart
Ophthalmoscope
Penlight
Cotton
Tongue blades
Pins
Reflex hammer
Test tubes for warm and cold water
Tuning fork
Otoscope

tial hallmark of an excellent clinician is the ability to collect all the appropriate data regarding the symptom of pain and the ability to analyze the data properly. To modify one of Osler's famous statements: "to know pain is to know medicine." The goal is to localize and characterize the painful sensation. Ask the patient to point to the maximum site of the pain, or to outline the afflicted region by using one finger. The following information must be collected (P,Q,R,S,T): provoking factors, quality, region including radiation, severity, and temporal relationships.

Muscle cramps (Chapter 53), usually a benign nuisance, can on occasion be the clue to serious conditions otherwise unsuspected. These disorders include the metabolic myopathies and various causes of myotonia. Collect the following information about cramps: time of occurrence in relationship to activity; precipitating factors; duration of cramp; age of onset; pain; weakness; presence or absence of dark-colored urine (myoglobinuria); contracture; drugs; family history; associated symptoms.

Headache (Chapter 54) is responsible for up to 16 million patient visits to clinicians per year. It is of great concern to patients and a challenge to physicians. A careful collection of data and thoughtful analysis will lead to one of three etiologic categories: vascular, myogenic, or traction. Life-threatening diseases (e.g., brain tumor or meningitis) commonly present as headache. Characterize the headaches by the following information: type of pain; temporal profile of pain; characteristics of pain; prodromes; precipitating factors; associated symptoms.

Cerebrovascular disease (Chapter 55) is of vital historic importance because specific therapy may prevent future disease. A history of cerebrovascular disease also serves as a marker for other diseases with shared pathogenesis, such as coronary artery disease. The clinical manifestations will help one classify the etiology as ischemic or hemorrhagic. In eliciting the history for cerebrovascular disease, begin with the presenting manifestation and then get each succeeding symptom, just as with the history of other diseases. Compile the following information: activity at time of onset (exercise, awakening from sleep, sedentary); presenting manifestation; specific neurologic deficits; associated symptoms such as chest pain, systemic diseases; temporal sequence and time course; risk factors for stroke; current functional capacity.

Epilepsy (Chapter 56) can be caused by many conditions: cerebral masses, infections, cerebrovascular disease, systemic diseases, trauma, metabolic causes, genetic influences. A careful and meticulous history will enable the clinician to sort out many of these causes. A seizure needs to be characterized as to aura, onset, ictus, and postictal phase.

Additional neurologic symptoms are given in Table 50.2, classified as to neurologic structure of origin. Open-ended questions as part of the Present Illness and Review of Systems will generally bring them to light. They should be asked about specifically when the history leads the clinician to suspect a disorder involving the structure(s) listed.

By the end of the interview the functional baseline, onset, temporal progression, and detailed manifestations of the present illness should have been obtained. The review of systems of the neurologic system will have been completed. However, the history can be supplemented easily and appropriately during the examination as abnormalities are discovered or additional questions occur to the examiner, or as additional details are remembered by the patient.

Table 50.2
Symptoms of Neurologic Disease

Structure	Manifestation(s)
Muscle	Weakness Cramps Atrophy Hypertrophy Myotonia Rhambdomyolysis
Myoneural junction	Weakness, fluctuating Fasciculations
Peripheral nerve	Pain Paresthesias Hypoesthesias Numbness Analgesia Weakness to paralysis Diminished to absent reflexes Decreased to absent touch, pain, temperature, vibration, joint position
Autonomic nerves	Orthostatic hypotension Syncope Impotence Incontinence Sweating abnormalities Gastrointestinal motility disturbances Secretory disturbances Cardiovascular reflex abnormalities Autonomic hyperreflexia
Spinal cord	Segmental motor, reflex and sensory abnormalities Radicular pain Upper motor neuron findings Lower motor neuron findings Bladder, bowel, and sweating disturbances
Cerebellum	Ataxia of gait Dysmetria Hypotonia Incoordination of extremities Titubation Eye movement abnormalities Voice abnormalities
Brainstem	Crossed manifestations (body/face) Cranial nerve disturbances (supranuclear and nuclear) Respiratory pattern abnormalities Disturbances of consciousness Sleep disturbances
Basal ganglia	Movement disorders Tremors Disturbances of tone Bradykinesia Loss of righting reflex
Cerebral cortex	Mental status abnormalities Epilepsy Upper motor neuron manifestations Visual, language, speech, somatosensory, hearing, and motor abnormalities

Neurologic Examination

The neurologic examination is performed after the history has been taken. The order of the examination varies from one neurologist to another, and is adapted to the condition of the patient and the environment of the examination. An orderly and systematic method of performing the exami-

nation should be developed early by the student, and adhered to such that it becomes a matter of habit.

Table 50.3 illustrates the order of procedure outlined in this overview. It is arranged in a logical and systematic fashion, at once practical and efficient, but at the same time observing certain important principles: A test on one side should be compared immediately with the same test on the other side, thereby providing information about laterality; each system (e.g, the motor or reflex system) should be examined in a block, so as to facilitate axial comparisons. Note that the examination is divided into five sections:

Section I:	Mental status
Section II:	Patient standing and walking
Section III:	Patient seated, facing examiner
Section IV:	Patient lying, face up
Section V:	Patient lying, face down

In a similar fashion, note that there are five principal divisions of the examination:

Division I:	Mental status
Division II:	Cranial nerves
Division III:	Deep tendon reflexes
Division IV:	Motor and coordination
Division V:	Sensory

Fix the five sections firmly in your mind; this will enable you to remember easily each position of the patient. The five divisions are also easily remembered and will enable you to recall exactly what to do next as you proceed from one position to another.

Start the examination by making sure the patient is comfortable and the circumstances are suitable: a well-lit room, quiet, with privacy. Begin by laying your instruments out on the table, so you will not have to grope continually for them. Instruments for the routine examination should include a scent such as vanilla for olfactory testing, a Snellen chart for visual acuity, ophthalmoscope, penlight, cotton, tongue blades, pins, reflex hammer, test tubes for warm and cold water, tuning fork, otoscope.

Table 50.3
Sequence of the Neurologic Examination

Position	Structures and functions examined	Chapter(s)
Sitting	Mental status examination	207
	Level of consciousness	57
	Language: spontaneous conversation repetition	66
	Dementia check: orientation; three objects; serial 7's; three-stage command; instruction; write; copy	
Standing	Gait and station	68
Sitting	Palpate skull; observe back	
	Cranial nerves:	
	I: test odor	59
	II: acuity; fields; fundi	115, 116, 117
	III, IV, VI: palpebral fissures; fixation; conjugate gaze; saccades; six positions; pupils	60
	V: corneal reflex; masseters; pterygoids	61
	VII: observe; eyelids; mouth; taste	62
	IX, X: voice; swallow; pharynx; gag	63
	XI: shoulder shrug; head turn	64
	XII: observe tongue; protrude	65
	Reflexes: jaw jerk; biceps; brachiorad; finger jerks; triceps; knee jerk; ankle jerk; plantar reflex	72
	Motor and coordination: observe fine movements; tone; palpate; drift; finger–nose; rapid alternating movements; grasp reflex; strength of deltoids, biceps, triceps, extensors, interossei, etc.	68, 69
Lying, face up	Motor and coordination continued	
	Observe muscles: tone; strength of quadriceps, hamstrings, thigh adductors, etc. Heel–knee–shin test; plantar reflex	73
	Head: neck, orbit, mastoid bruits; flex neck; Brudzinski; Kernig	18
	Sensory: trigeminal; upper extremities; anterior trunk; lower extremities. Joint position and vibratory upper and lower extremities	67
Lying, face down	Observe muscles; check sensation; anal reflex and sphincter tone	

The Mental Status Examination

The mental status examination can be performed either at the beginning or end of the examination. The decision as when to do the examination is made during the first few minutes of taking the history, which, in effect, is the first part of the mental status examination. Defer the mental status examination until later in a patient who comes across as normal during the initial minutes of the interview. If the patient appears to have a grossly abnormal mental status initially, then the examination should be done at that moment, instead of proceeding with the formal history and review of systems. A patient who is obviously confused will not be able to give a reliable history; the examiner needs to characterize the problem as a first priority in this case. An advantage to doing the mental status at the end, if no dysfunction is suspected, is that a relationship has been established with the patient, a detailed neurologic examination has been performed, and the patient will be more likely to accept the mental status examination as a natural part of the neurologic examination.

There are three principal parts to the mental status test: level of consciousness, language, check for dementia. The *level of consciousness* is assessed by observation and by testing response to stimuli: alert, stuporous, lethargic, and comatose are the descriptive terms used. A patient who grossly has a decreased level of consciousness should be tested for response to stimuli, beginning with the least stimulus (softly spoken first name), escalating to more and more noxious stimuli (see Chapter 57). *Language* is tested next (Chapter 66). Spontaneous conversation during the initial phase of

history taking gives important clues: articulation, fluency, grammatical errors, word errors. Ask the patient to repeat a sentence such as "Today is Tuesday, January 2, 1990." This tests both repetition and comprehension in one stroke. Language is further tested with the *dementia check,* which most conveniently utilizes the Mini-Mental Status examination of Katz et al:

Year/season/date/day/month

State/country/town/hospital/floor

Remember three objects

Serial 7's

Name three objects

Follow three-stage command

Read and obey an instruction

Write a sentence

Copy a design

With experience, much of the information listed above can be elicited unobtrusively during the history and physical examination. For example, "Where do you live?" is a natural question to ask early in the interview. With experience you can smoothly integrate the mental status examination into the session at an appropriate time and in an easy fashion.

Patient Standing

The *gait and station* can be done first, before the patient has disrobed, or at the very end. In many cases one will want to see the patient walk both dressed and with shoes, and without shoes in an examining robe. The patient is asked to stand in his or her usual stance and then to walk normally. After this the patient walks on the toes, then on the heels, and then in tandem. Finally the patient is asked to stand with the eyes closed for the Romberg test. The examiner should always be ready to prevent a fall during the last few maneuvers.

Patient Seated

The patient now sits on the examining table or bed, dressed in a gown, facing the examiner. The examiner palpates the skull, walks around behind the patient and observes the back. Return to the front of the patient and begin the examination of the cranial nerves, starting with I and proceeding systematically through XII.

Begin testing *cranial nerve I* (Chapter 59) by explaining to the patient what you are about to do. Then have the patient occlude one nostril with the index finger, and close his or her eyes. The examiner presents a test odor, such as candy, vanilla, or tobacco, and the patient indicates when the odor is perceived. The other nostril is then tested. Be careful not to give auditory clues.

Cranial nerve II is tested: visual acuity, visual fields, and finally the fundi. Place a Snellen chart 6½ m from the patient and record the smallest line the patient can read with one eye and then the other. For the purposes of the neurologic examination, glasses may be used. If visual acuity is markedly decreased, the patient may be asked to count fingers—equivalent to about 20/400 size letters. The visual fields are then examined. Start with face confrontation. Stand directly in front of the patient, who holds a small card or hand over the eye not being tested. The examiner closes his or her matching eye. Look directly into the patient's eye, and move a pencil or other small object (such as a wisp of cotton on an applicator stick) into the patient's field of vision equidistant between the examiner's and patient's eyes. The examiner's eye is thus being used as a control. The four quadrants of vision are tested separately for each eye. Next examine both visual fields of the patient at the same time. Stand in front of the patient, looking into his or her eyes. Hold both hands outstretched at the outer limits of vision of both you and the patient. Move the fingers on the right and left hands randomly, asking the patient to identify the hand with the moving fingers. Occasionally move the fingers on both hands simultaneously, thereby testing for visual extinction. Other methods for examining the visual fields are given in Chapter 116. Finally, observe the fundi. The room should now be semidarkened. Place the lens on zero, stand about ½ meter in front of the patient, and begin by observing the ocular media (aqueous humor, lens, and vitreous). Slowly approach the patient, continuing to look into the pupil, until the retina is identified. Then systematically examine the disk, each of the four retinal vessels, and finally the macula.

Cranial nerves III, IV, and VI are tested (Chapter 60): equality of palpebral fissures, fixation, conjugate gaze, action of extraocular muscles in the six diagnostic positions of gaze, and the pupil. Begin by observing the equality of the palpebral fissures: Inequality can mean ptosis (smaller fissure) or weakness of the VIIth nerve (larger fissure). Assess fixation by having the patient look at an object 1 m away, and then one about 6½ m away; observe for the ability to maintain fixation and for nystagmus. Conjugate gaze is tested by asking the patient to follow his or her finger as it is moved back and forth (pursuit movements). Saccadic movements are assessed by asking the patient to fixate on an object, such as the examiner's finger, held directly in front of the patient about 1 m away, and on command to shift gaze to a finger on the other hand of the examiner, held about 60 cm away from the first finger. Now test the action of the yoke muscles of the eyes in the six diagnostic positions of gaze: Ask the patient to follow your finger or penlight as you move it to the left, right, up, down, up and down at the extremes of lateral gaze to the left and right. Observing light as it is reflected on the eye during these movements is more accurate than watching the entire globe. Ask the patient to inform you if there is diplopia. Observe failure of conjugate movement of one eye and for nystagmus. The pupil is next. Observe for shape and equality of pupils. Test accommodation by asking the patient to fixate on a distant object, then look at his or her finger as it approaches the nose. Then test direct and consensual reaction to light in both pupils with a penlight.

Cranial nerve V (Chapter 61) has a number of functions that are tested: the corneal reflex; touch and pain over the three sensory divisions; the strength, size, and tone of the masseter and pterygoid muscles; the jaw jerk. The jaw jerk is logically tested with the reflexes of the rest of the body. Pain and touch testing of the face can also be done with the rest of the sensory system. Consequently these techniques will be given later. Begin with the corneal reflex; twist a wisp of cotton into a point, tell the patient what you are going to do, and touch the junction of the cornea and sclera gently but firmly as the patient looks in the other direction (Figure 50.1). Now observe the masseters for equality and

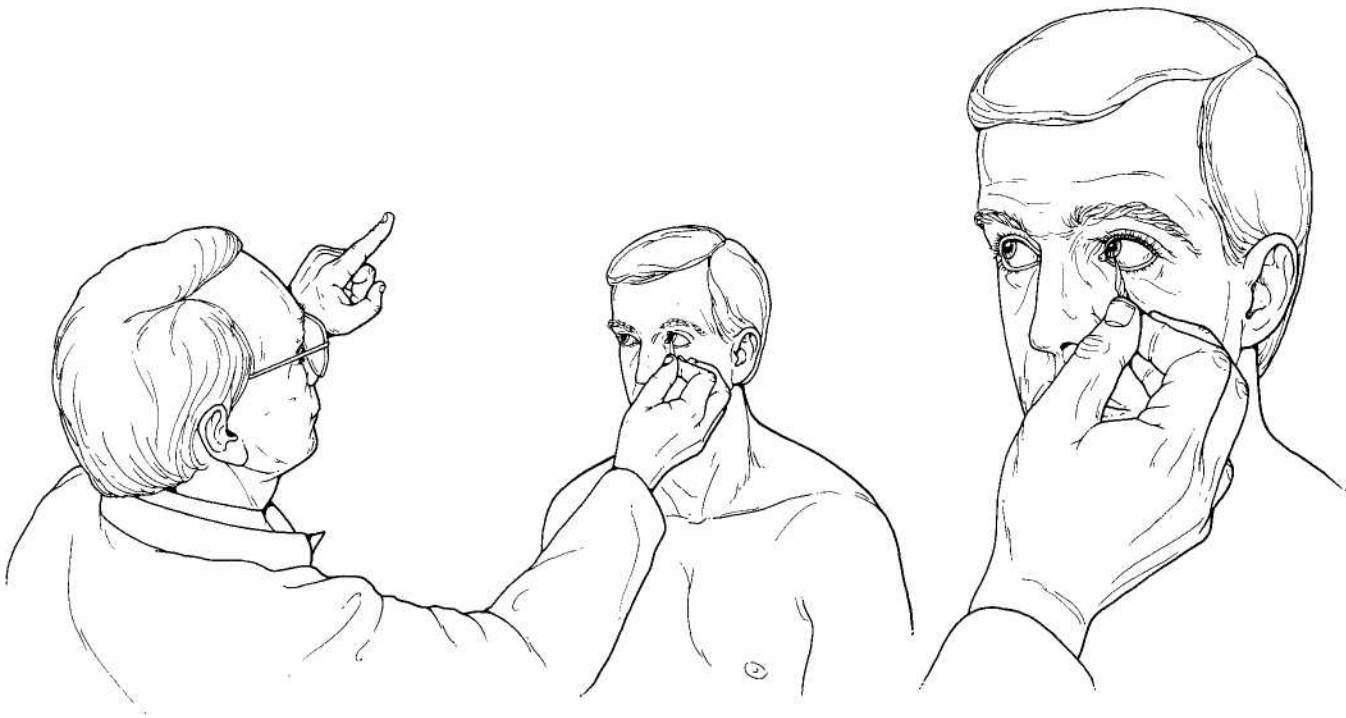

Figure 50.1
Testing the corneal reflex. The patient is instructed to look at the examiner's finger, which is held above and to the right when the left eye is being tested. This direction of gaze ensures that the movement of the examiner's other hand will not serve as a visual threat. *(Insert):* A twisted wisp of cotton is used to touch the eye firmly but fleetingly at the junction of cornea and sclera. The eye tested will blink rapidly; the other eye will blink consensually less strongly.

bulk, palpate them for tone, and test strength by having the patient clench the jaws. Ask the patient to open the mouth: The tip of the mandible should open in the midline if the pterygoids are normal. Let the patient move the jaw from side to side against the resistance of your hand to further test for pterygoids.

Cranial nerve VII (Chapter 62) has been observed now for a considerable time as you have been doing the rest of the examination. Observation during conversation and at rest is the best way to pick up subtle weakness. Especially note asymmetry of blink, equality of the wrinkles and folds on both sides, and movement of the mouth. Ask the patient to look up, and observe the wrinkles on the forehead. Then carefully observe for equality of eyelid burying as both eyes are clenched shut; this is also a good time to look at the mouth for slight weakness. Finally ask the patient to put on a big smile. Taste is tested by smearing a small amount of sugar or salt on the side of the anterior portion of the tongue with the patient's eyes closed, and asking for a description of the substance.

Cranial nerve VIII is tested for auditory acuity and the tuning fork tests. Whisper a few feet from each ear, and ask the patient what you said. Take a tuning fork (usually 256 Hz), activate it, and place it in the midline of the head. Ask the patient where the sound is perceived (normal: midline). Activate the fork again, place it over the mastoid process, and ask the patient to identify the moment the sound stops; then hold it 2.5 cm from the ear, where the patient should be able to continue hearing it. In other words, air conduction should be better than bone conduction.

Cranial nerves IX and X (Chapter 63) involve talking and swallowing. Listen for dysarthria or hoarseness. Give the patient a glass of water to swallow. Inspect the palatal arches for symmetry. Have the patient say "Ahhh . . ." and observe the palatal arches as they contract and the palate swings up and back. Take the tongue blade, tell the patient what you are going to do, and then touch first one arch then the other in order to test the gag reflex. The posterior portion of the tongue is not ordinarily tested for taste.

Cranial nerve XI (Chapter 64) innervates the trapezius and sternocleidomastoid muscles. Ask the patient to shrug the shoulders (trapezius). Place the palm of your hand on the chin, and have the patient turn the head against your resistance while you inspect and palpate each sternocleidomastoid.

Cranial nerve XII (Chapter 65): Observe the tongue for atrophy, fasciculations, and deviation from the midline as it rests in the mouth. Ask the patient to poke the tongue into each cheek while you feel the cheek and the strength of the tongue behind the cheek. Have the patient protrude the tongue from the mouth; it should be in the midline.

The *deep tendon reflexes* are tested next. Begin with the jaw jerk: Place your index finger over the tip of the mandible, and strike your finger gently but briskly with the reflex hammer (Figure 50.2). The limb deep tendon reflexes are tested now; each reflex is tested on both sides before moving to the next one. Do the biceps reflex: Place your thumb over the biceps tendon, with the patient's arm midway between flexion and extension, and strike your thumb briskly (Figure 50.3). Do each brachioradialis: Strike the tendon gently but briskly, where it lies about 1 cm lateral to the radial artery (anatomic position of arm) at the wrist (Figure 50.4). The finger jerks are next: The patient's fingers are curled over your index finger, much as a bird curls its claws around the branch of a tree. Strike your index finger and feel the contraction of the patient's fingers (Fig-

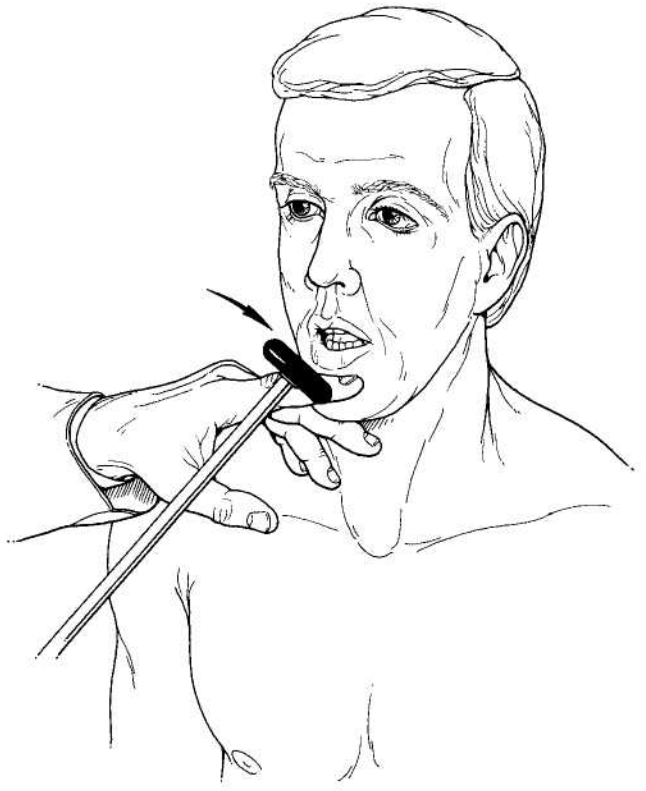

Figure 50.2
The jaw jerk. Place the tip of your index finger on a relaxed jaw that is about one-third open. Tap briskly on your index finger with the reflex hammer, and note the speed as the jaw closes. This is the highest deep tendon reflex that is tested.

ure 50.5). The triceps tendon is tapped just above its insertion into the olecranon. Cradle the patient's arm in yours midway between flexion and extension (Figure 50.6). The knee jerks are next. Tap the tendon briskly as the patient sits on the table (Figure 50.7). Then place your hand under the anterior sole of the foot, elevate the foot just enough to put a slight amount of tension on the achilles tendon, and tap the tendon for the ankle jerk (Figure 50.8). In many cases you will want to recheck the reflexes when the patient is lying down, once again carefully comparing one side against the other and upper with lower reflexes.

Motor function and coordination are tested with the patient remaining in the seated position facing the examiner. Begin by observing the muscles carefully for atrophy, hypertrophy, fasciculations, or other abnormal movements. Observe fine movements throughout the entire session: fingering the bedclothes, unbuttoning clothes, adjusting clothes, etc. Note the tone in each muscle group as you examine: hypertonia, hypotonia, spasticity, flaccidity, rigidity, cogwheeling. Palpate each muscle group as it is examined. Begin by asking the patient to hold both arms out in front, with eyes closed. Watch for drift, pronation, tremor, asterixis, chorea, and any other abnormality. It is convenient at this time to check finger–nose, finger–nose–finger, and rapid alternating movements, comparing each extremity to the other, just as with the reflexes. The grasp reflex can be checked now (Figure 50.9). End the upper extremity examination by testing the strength of the deltoids, biceps, triceps, wrist and finger extensors, interossei, opponens policis, and abductor digitorum quintus on each side (Figure 50.10).

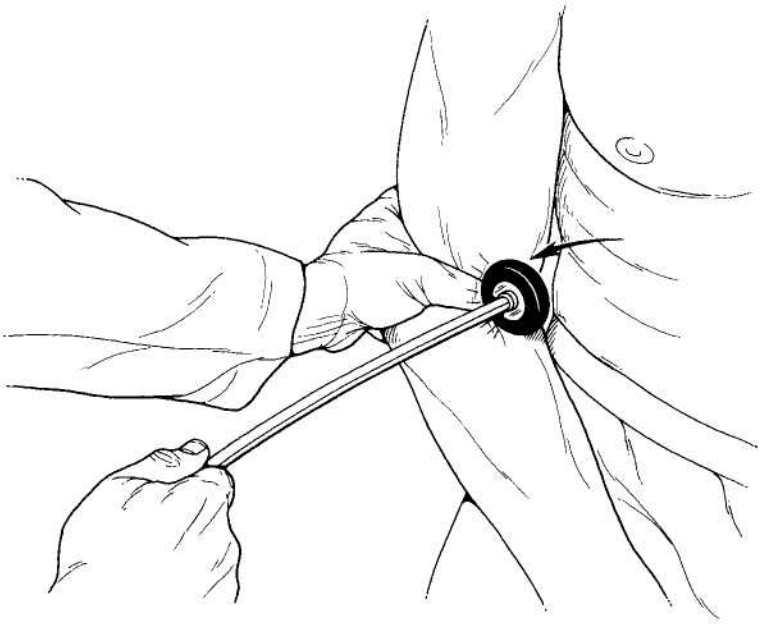

Figure 50.3
The biceps reflex. The patient's forearm is supported on the thigh. The arm is midway between flexion and extension. Place your thumb firmly over the biceps tendon, with your hand curling around the elbow, and tap briskly on your thumb. The forearm will flex at the elbow.

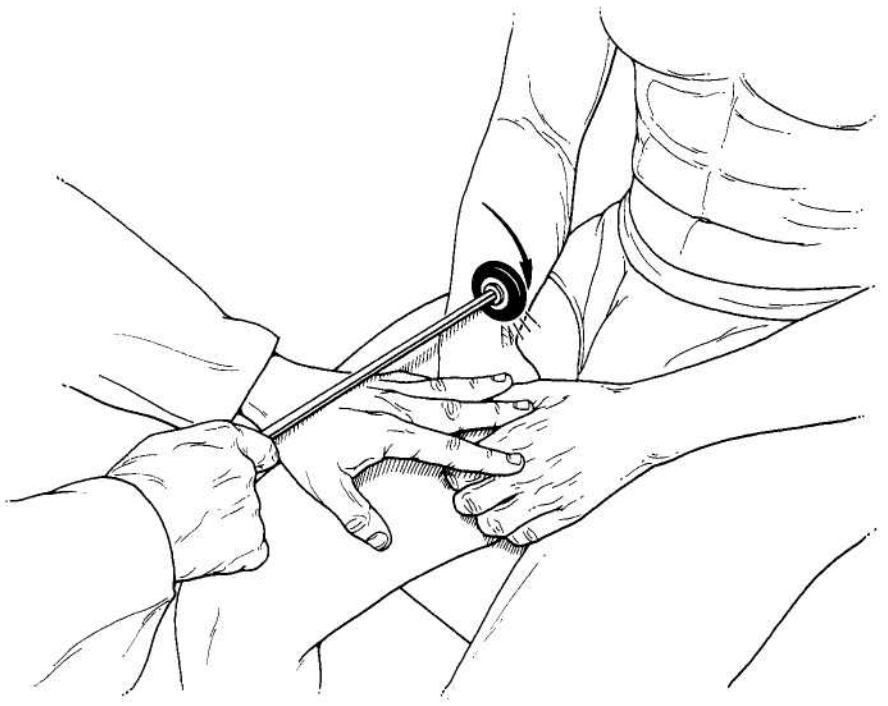

Figure 50.4
The brachioradialis reflex. The patient's arm is supported on the thigh below and by the examiner's hand above. Identify the insertion of the brachioradialis tendon on the radius. Briskly tap it with the reflex hammer. The reflex consists of flexion and supination of the forearm. The biceps and/or finger jerk reflexes may also respond to tapping on the brachioradialis tendon if they are brisk.

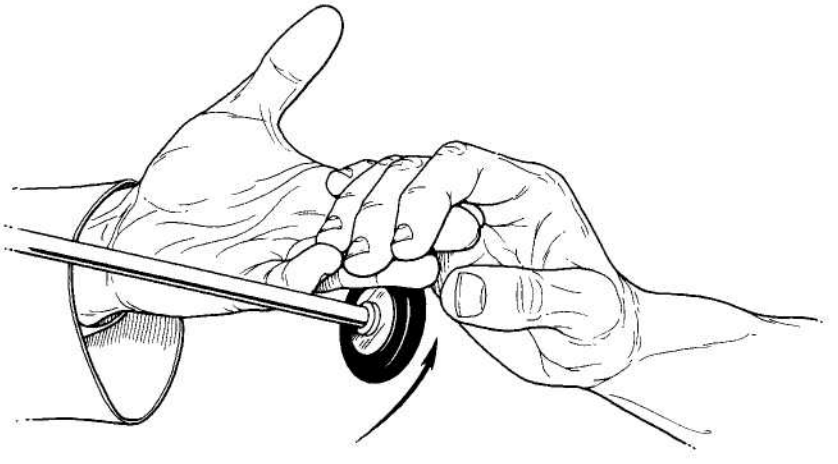

Figure 50.5
The finger jerk. Place your hand as illustrated under the patient's fingers. Lift the patient's fingers with your hand. The wrist should be slightly extended, putting a small but definite degree of tension on the finger flexors. Then strike your fingers briskly with the reflex hammer and note the reflex flexion of the patient's fingers.

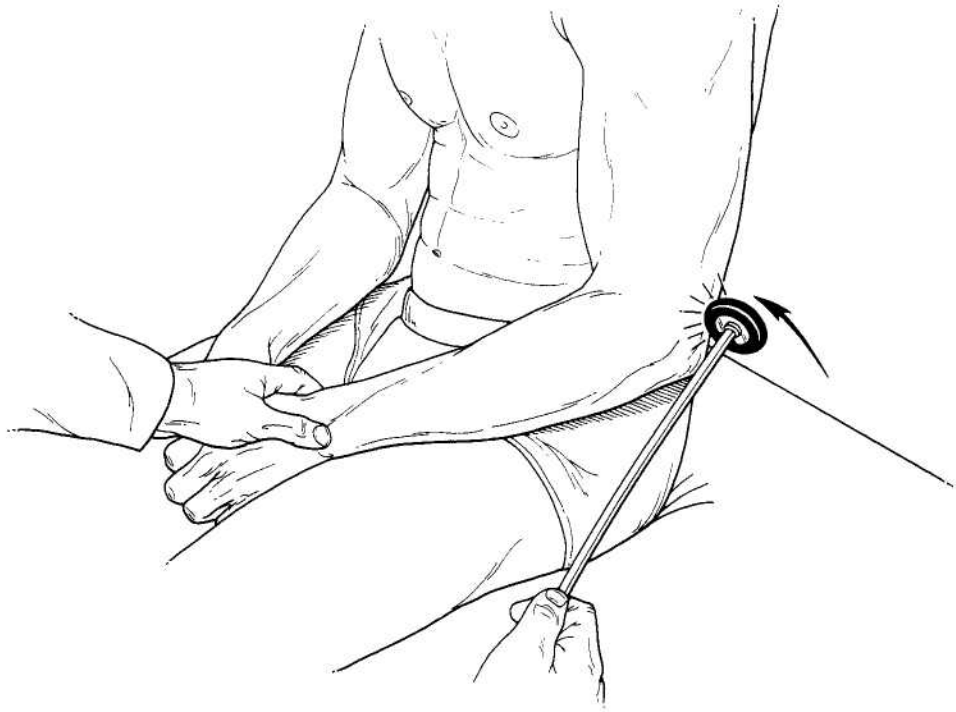

Figure 50.6
The triceps reflex. Place the patient's arm on the thigh for support. The arm is midway between flexion and extension. Identify the triceps tendon posteriorly just above its insertion on the olecranon. Tap briskly on the tendon with the reflex hammer. Note extension of the forearm.

Figure 50.7
The knee jerk. Let the knee swing freely. Place your hand on the lower leg, as illustrated, in order to check an unexpectedly lively reflex. Tap the patella tendon briskly, noting extension of the lower leg. Observe the quadriceps and note if it contracts also. On occasion the contralateral leg will adduct concomitantly, indicating brisk contralateral reflexes.

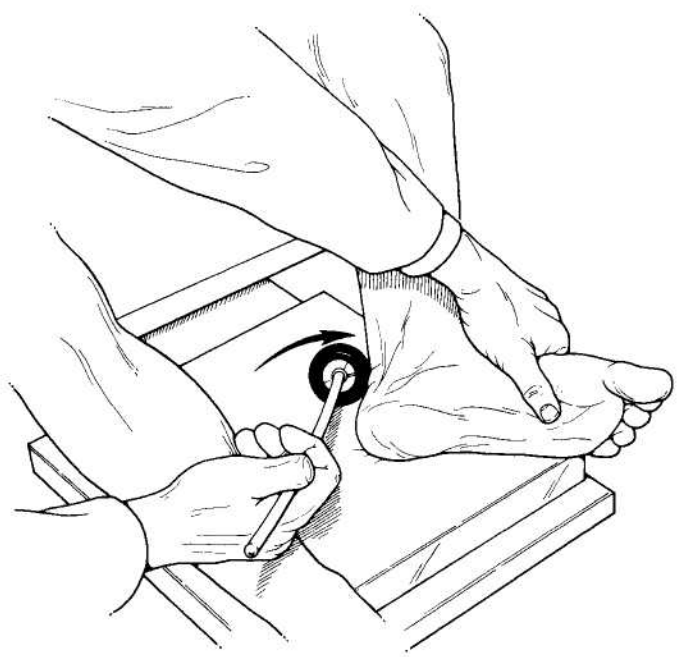

Figure 50.8
The ankle jerk. Place one hand on the sole of the patient's foot and dorsiflex and foot slightly. The patient should exert slight tension on your hand. A helpful device is to tell the patient to "press on my hand with your foot as though you were pressing on the accelerator of your car just hard enough to go five miles an hour."

Tap the Achilles tendon briskly just above its insertion on the calcaneus. If the patient is in bed, flex the leg at the knee, and cradle the foot and lower leg in your arm. Ankle jerks are notoriously difficult to obtain. Chapter 72, The Deep Tendon Reflexes, has additional maneuvers to try in the event of difficulties.

Figure 50.9
The grasp reflex. The examiner's hand is gently inserted into the patient's hand, usually while distracting the patient with conversation. Slowly withdraw your hand across the palmar surface in a stroking motion. The flexor surfaces of the fingers may be stimulated also. With a positive grasp reflex the patient grasps your fingers as you withdraw them, and continues to involuntarily grasp with variable strength as the fingers are withdrawn. Upon occasion the grasp may be so strong as to enable you to lift the patient off the bed.

Patient Lying Face Up

Ask the patient to lie flat on the examining table or bed, no pillow, arms stretched out by the side, face up. Continue with the motor examination in the lower extremities. Remember that the gait testing initiated the lower extremity motor and coordination examination. Observe the muscles as in the upper limbs. Check tone and strength of the quadriceps femoris, hamstrings, thigh adductors, extensors of ankle and toes, and long flexors of ankles and toes (Figure 50.11). Do the heel–knee–shin test for coordination: Ask the patient to tap on one knee with the other heel, gently. Then take the heel and run it down the tibia, beginning at the knee. Repeat on the other side.

This is a convenient time to do the plantar reflex; another time was just after the ankle jerk testing. Draw the tip of your fingers or thumb along the lateral plantar surface, watching for extension of the great toe (Babinski's sign). If this does not occur, take a sharp object, since this is a nociceptive reflex, and draw along the same line, then successively medially until it is clear that extension is not going to occur. A vertically split tongue blade, gently applied, is a good test object (Figure 50.12).

Now go back to the head and complete certain unfinished parts of the examination there. Take up the stethoscope again. Listen over each carotid artery for bruits. Move up

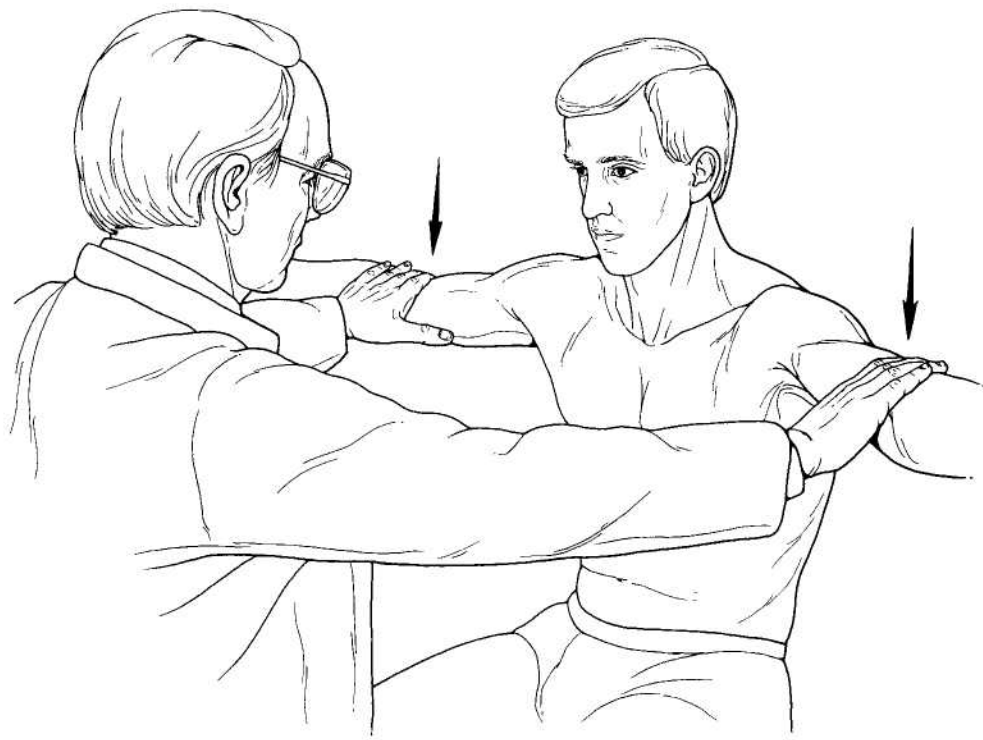

Figure 50.10
Testing the strength of the deltoids. The patient holds arms outstretched while the examiner pushes the forearms down. This is a good screening test for mild proximal weakness.

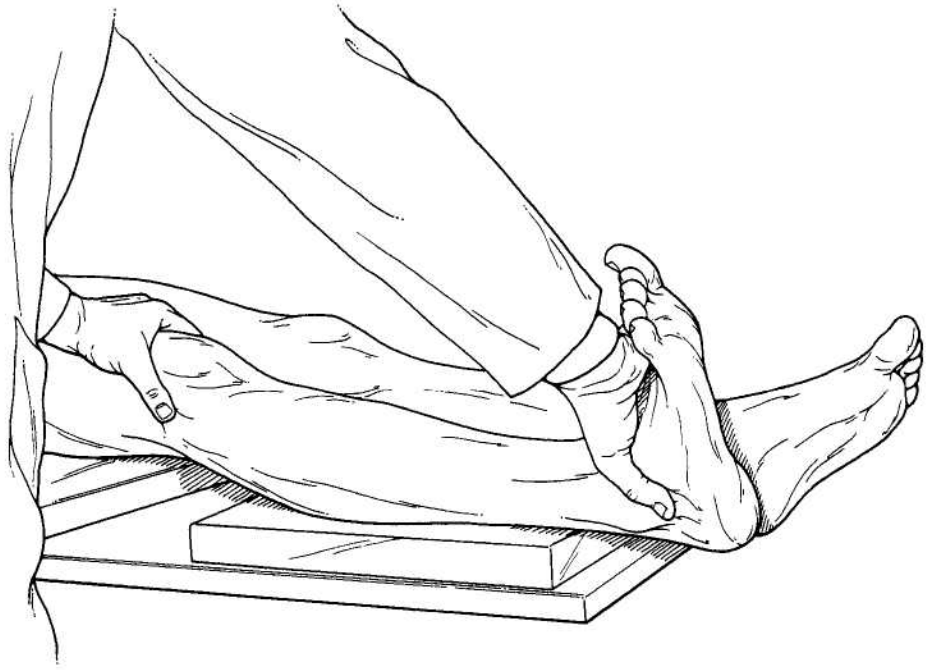

Figure 50.11
Testing the strength of the dorsiflexors of the foot. Fixate the leg with your hand above the knee as illustrated. Ask the patient to "pull your toes toward your face and hold them there." Attempt to overcome the muscles with your other hand while they are contracting maximally. This maneuver, when combined with testing the knee and hip flexors, provides a good screening test in the lower extremities for mild dysfunction of the corticospinal system.

Figure 50.12
The plantar reflex. Fixate the foot with your hand as illustrated. Stroke the lateral surface of the sole in the direction of the toes. Begin with gentle stroking, using your thumb. In many patients this is sufficient to elicit the reflex, and has the advantage of decreasing the possibility of arousing a withdrawal response. If there is no response use a blunt object such as a key or pen. Finally, if no abnormal response has been obtained, take a tongue blade, break it in half longitudinally, and stroke carefully with the sharp point. The reason for the graded stimuli is twofold: light stroking with the thumb often elicits the reflex without reflex withdrawal. Secondly, the abnormal reflex is a nociceptive reflex—i.e., a noxious stimulus is required before concluding the reflex is normal. The normal reflex is flexion of the great toe. Toe extension is known as the Babinski reflex.

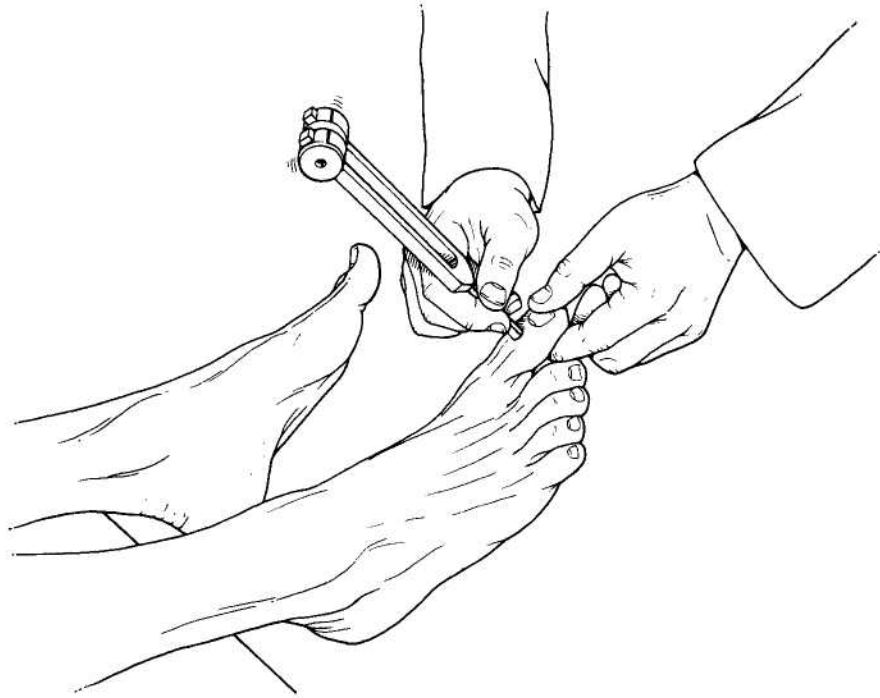

Figure 50.13
Testing vibratory sensation. The distal joint of a toe or finger is used, since disturbance of function occurs earliest and most severely distally. Take a 128/second or C tuning fork and strike it maximally, noting the time of striking. Place the fork on the most distal joint, and ask the patient to tell you what is felt. They will usually say a "buzzing" or "like electricity." Instruct the patient to tell you instantly when the sensation ceases. Note the time elapsed since striking the tuning fork. The normal range is usually in excess of fifteen seconds, with below ten seconds being abnormal.

to the head and listen over each orbit for bruits: Instruct the patient to close both eyes, then place the bell of your stethoscope over the eye, and ask the patient to open the opposite eye (this relaxes the muscle of the eye you are testing and diminishes the noise in the orbit). Finish the auscultation by listening over each mastoid. Now flex the head and neck, testing for meningismus. Observe the legs for involuntary flexion when you do this (Brudzinski's sign). Now flex the thigh on the abdomen, and then straighten the leg at the knee; inability to straighten the leg at the knee to 135 degrees is Kernig's sign.

The *sensory examination* from head to toe is done now. Explain to the patient what is required of him or her. Take a wisp of cotton (or the ball of your index finger, applied with an angel's touch) and a safety pin. Begin with the three divisions of the trigeminal nerve on the face. (Remember the corneal reflex—pain to the eye—has already been tested.) Move to dermatomes C2 to T2, then T2 to S5. (The abdominal reflexes, upper and lower, and cremasteric reflex can be tested incidentally while pin is in hand.) Joint position can now be tested in the upper and then lower extremities. Take a finger such as the ring finger, grasp each side distally, and with the patient's eyes closed, move the distal joint a few millimeters up or down, with the patient reporting each movement. Do this on both sides, then repeat with one toe—usually the second one—on each side. Then test vibratory sense in the upper then lower extremities: Take a 126 Hz tuning fork, strike it maximally, and apply to the most distal joint of the same digit examined in the joint position test. Measure the length of time until the patient no longer perceives the vibration: Under 10 seconds is abnormal, 15 or over normal; 10 to 15 is a gray zone (Figure 50.13).

Patient Lying Face Down

Now ask the patient to roll over face down. Carefully observe all the muscles for atrophy and fasciculations. Check sensation from C2 to S5 dermatomes with cotton and pin. When appropriate, test the anal reflex and check sphincter tone.